



## **LIFE CYCLE COST ANALYSIS GUIDELINES 2008**

**Department of Natural Resources**

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## INTRODUCTION

The purpose of this guideline document is to assist architects and engineers in completing life cycle cost reports required by the Code of Iowa for public facilities. These guidelines provide a methodology intended to standardize analysis reporting and to facilitate a timely and accurate technical review.

Life cycle cost analysis (LCCA) is an economic method used to evaluate building design alternatives with different levels of energy efficiency. It is a method that can be applied to any capital investment decision in which higher initial costs are exchanged for reduced future operating costs. The mutually exclusive design alternative with the lowest life cycle cost is the most cost-effective.

### When Required

The Code of Iowa defines when an LCCA is required when it states that "... a public agency responsible for the construction or **renovation** of a **facility** shall... include as a design criterion the requirement that a life cycle cost analysis be conducted for the facility." (emphasis added)(470.2) Pertinent Code (470.1) definitions are as follows:

- "'Facility' means a building having twenty thousand square feet or more of usable floor space that is heated or cooled by a mechanical or electrical system or any building, system, or physical operation which consumes more than forty thousand British thermal units (BTUs) per square foot per year."
- "'Renovation' means a project where additions or alterations exceed fifty percent of the value of a facility and will affect an energy system."

### Timing of a Life-Cycle Cost Analysis

LCCAs must be completed and approved early in the design process before system selection decisions are finalized. Iowa Code states that a "life cycle cost analysis shall be approved... before contracts for the construction or renovation are let." (470.4)

### Review and Approval Procedure

The public agency responsible for the new construction or renovation is to submit the LCCA report to the Iowa Department of Public Safety for review. (Contact the Department of Public Safety, Fire Marshal Division, Building Code Bureau for submission instructions at 515/725-6145 or [bcinfo@dps.state.ia.us](mailto:bcinfo@dps.state.ia.us)). The Building Code Bureau will forward one copy of the LCCA report to the Iowa Department of Natural Resources' (Department) Energy and Waste Management Bureau for technical review and approval. The purpose of the technical review is to verify compliance with the Code of Iowa and that cost estimates, assumptions, and conclusions are reasonable and accurate.

Upon completion of the Department's review, if there are technical problems or if the Department disagrees with any aspects of the report, the Department will request

clarification or revision of the report. A letter will be sent to the public agency or design professional that submitted the report. Any requested revisions or clarifications will be promptly submitted in writing to the Department. This process continues until the report is approved in writing by the Department. A copy of the approval letter is sent to the State Building Code Bureau. The technical review and approval shall be completed before the letting of contracts for the construction or renovation of a facility. (470.7)

Contact the Building Code Commissioner (at 515/725-6145 or [bcinfo@dps.state.ia.us](mailto:bcinfo@dps.state.ia.us)) about additional requirements for buildings that are subject to the State Building Code and review by the State Building Code Bureau.

## **Technical Requirements**

Iowa Code states that a public agency or a person preparing a life cycle cost analysis for a public agency “shall consider the methods... provided by the department”. These guidelines are intended to serve this purpose.

Code of Iowa Section 470.1.5 lists the minimum equipment or measures to be analyzed in an LCCA including:

- (1) the equipment used to heat or cool the facility
- (2) equipment used to heat the water
- (3) on-site electric generating equipment

## **Incremental Financing**

Section 20 of Chapter 473 of the 2007 Code of Iowa includes the requirement that a school district, community college, area education agency, city, or county “shall design and construct the most energy cost-effective facilities feasible and shall use the financing made available by the Department to cover the incremental costs above minimum building code energy efficiency standards of purchasing energy efficient devices and materials unless other lower cost financing is available.” (473.20.5)

Contact Mike Adams (515) 281-4262 ([michael.adams@dnr.iowa.gov](mailto:michael.adams@dnr.iowa.gov)) or Lee Vannoy at (515) 281-6559 ([lee.vannoy@dnr.iowa.gov](mailto:lee.vannoy@dnr.iowa.gov)) for more information about Iowa Energy Bank financing through the Department.

## ANALYSIS PROCEDURE

The goal of life cycle cost analysis procedures is to select the building design with the lowest life-cycle cost from a set of alternatives. The analyst is to consider design alternatives for the domestic hot water system, lighting system, and combinations of the building envelope and HVAC (heating, ventilation, and air-conditioning) systems. When applicable, the analyst is to consider design alternatives for on-site electricity generation.

Each analysis is to be based on a 25 year study period and shall use U.S. Department of Energy Federal Energy Management Program (FEMP) discount factors (refer to the *Resources* section below). When the useful life of a system or system component is less than the study period, the analysis must include the replacement cost and then account for the residual value at the end of the study period. Residual value is assumed to be the remaining value at the end of the study period. As a general rule the residual value of a system or system component can be calculated by linearly prorating its initial cost. Any residual value is then used to reduce the system life cycle cost. Appendix C lists equipment service lives to be used in life cycle cost analyses.

The analysis methodology must first consider interaction between energy-using systems. When the amount of energy consumed by one system impacts the energy consumed by another, this interaction must be carefully considered in the analysis. The accepted methodology is for the analysis to first evaluate independent systems followed by systems that interact. The analysis procedure is as follows:

- 1) Find the life cycle cost of three domestic hot water system alternatives and select the one with the lowest life cycle cost.
- 2) Find the life cycle cost of three lighting system alternatives and select the one with the lowest life cycle cost.
- 3) Use the recommended domestic hot water and lighting systems and find the lowest life cycle cost combination of three building envelopes and three HVAC systems. There will be combinations of nine building envelope-HVAC system alternatives to evaluate.

There will be fifteen life cycle cost calculations including an analysis of three domestic hot water alternatives, three lighting alternatives, and nine building envelope-HVAC system alternatives.

When applicable:

- 4) Use all of the recommended building systems to evaluate three on-site electric generation system alternatives and recommend the one with the lowest life cycle cost. In the case of wind turbine generation, refer to the Department's current version of the Wind Feasibility Study Guidelines for specific wind turbine-related requirements.

## Resources

A particularly useful reference for life cycle costing procedures is the *Life-Cycle Costing Manual for the Federal Energy Management Program*, National Institute for Standards and Technology (NIST) Handbook 135, 1995 Edition. This 10 MB manual can be downloaded on the internet from:

<http://www1.eere.energy.gov/femp/program/lifecycle.html>

or

<http://www.bfrl.nist.gov/oae/publications/handbooks.html>

Alternatively, this manual can be ordered from:

National Technical Information Service  
5285 Port Royal Road  
Springfield, Virginia 22161  
(800) 553-6847 or  
(703) 487-4650

In April of each year NIST also publishes an annual supplement to Handbook 135 titled “Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis”. This supplement includes discount factors to be used in life cycle cost analysis calculations. The analyst should use current discount rates, however, only U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) rates are to be used. (Do not use Office of Management and Budget (OMB) rates.)

Analysts without internet access or analysts unclear on the appropriate rates to use may contact Lee Vannoy at (515) 281-6559 or [lee.vannoy@dnr.iowa.gov](mailto:lee.vannoy@dnr.iowa.gov). The current supplement to Handbook 135 can be downloaded from:

<http://www1.eere.energy.gov/femp/pdfs/ashb07.pdf>

The manual and the annual supplement is in Adobe Portable Document Format (PDF) so the Adobe® Acrobat® Reader® software must be used. Acrobat Reader can be downloaded from the internet at:

<http://www.adobe.com/products/acrobat/readstep2.html>



## **STANDARD FORMAT FOR LIFE CYCLE COST REPORTS**

The format of LCCA reports that are submitted should be similar to the format of the following guidelines. LCCA reports are to be stand-alone documents, meaning that they are to include all information needed for the review, and for future reference.

The order of sections and appendices are:

1. Professional Certification
2. Executive Summary
3. Project Identification
4. Assumptions Form
5. Discount Factor Summary Table
6. Life-Cycle Cost Analysis
  - A. Domestic Hot Water
  - B. Lighting
  - C. Building Envelope and HVAC System
  - D. On-Site Electric Generation
  - E. Recommended Systems
7. Appendix

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## **Section 1: Professional Certification**

The first form required is the Certificate of Responsibility (refer to the following page). The report must be certified by either a registered Architect or a licensed Professional Engineer in Iowa.

Iowa has adopted the 2006 International Energy Conservation Code as its energy code for commercial buildings, so this is the base case for each alternative studied. The analyst is to answer the question at the bottom of the form to verify that all design options in the report comply with the energy code.

<b>Certificate of Responsibility</b>
--------------------------------------

**Professional Engineer**

<b>SEAL</b>	<p>I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.</p> <p>(signature) _____ (date) _____</p> <p>Printed or typed name _____</p> <p>My license renewal date is December 31, _____.          Pages or sheets covered by this seal:</p> <p>_____</p> <p>_____</p> <p>_____</p>
-------------	---

**Registered Architect**

<b>SEAL</b>	<p>I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and responsible charge. I am a duly registered architect under the laws of the state of Iowa.</p> <p>Printed or typed name _____</p> <p>Signature _____ Date _____</p> <p>Registration Expires _____ Date Issued _____</p> <p>Pages or sheets covered by this seal:</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>
-------------	---

<p><b>Do the designs in this report meet Iowa energy code requirements as adopted from the 2006 International Energy Conservation Code?</b></p>
---

<p>____ Yes ____ No</p>
-------------------------

## Section 2: Executive Summary

The Executive Summary is to include:

- an explanation of the purpose of the report
- a summary of important findings of the report
- a description of important assumptions and special design considerations used in the analysis
- system selection recommendations based on lowest life cycle cost
- *Life-Cycle Cost Analysis Summary* form

The *Life-Cycle Cost Analysis Summary* form must be provided in the Executive Summary (refer to the next page). The *Life-Cycle Cost Analysis Summary* form tabulates the findings of each system alternative evaluated in the report and provides the derivation for the annual energy budget for the base case and for the facility alternatives yielding the lowest life cycle cost. The derivation of the annual energy budget should not double count energy consumption data, such as lighting energy that is often also included in HVAC system energy consumption calculations.

<b>Life Cycle Cost Analysis Summary</b>
---

Building Area \_\_\_\_\_ square feet

System	Description	Option Number	Electricity (kWh)	Natural Gas (Therms)	Annual mmBtu	Annual Energy Cost (\$)	EUI (Btu/sq.ft./year)	Life Cycle Cost (\$)	Initial Cost (\$)
Lighting / Electrical		1							
		2							
		3							
Domestic Hot Water		1							
		2							
		3							
Envelope & HVAC combinations		1A							
		1B							
		1C							
		2A							
		2B							
		2C							
		3A							
		3B							
		3C							
Electricity Generation		1							
		2							
		3							

Notes:

1. Designate each recommended system.
2. The Base Case are the systems with the lowest initial cost.

<b>Base Case Totals</b>			
<b>Recommended Systems Totals</b>			
<b>Difference (Base Case minus Recommended)</b>			

### Section 3: Project Summary Information

The second form required is the *Project Summary Information* form (refer to the following page). The form is divided into four areas including a project summary, a listing of institution and design professional contact information, and a description of special design considerations or constraints.

The project summary section includes general information about the building as well as specific building design information. Fill in notes pertaining to the following:

- Building Type
- Building Square Footage
- Number of Floors
- Estimated Number of Occupants
- Slab-on-grade?
- Partially below grade?
- Mechanical cooling?
- Renewable resources used?
- On-site electric generation?
- Estimated annual occupancy hours

The next two sections are to provide project contact information (including support staff) involved in the report preparation.

The final section provides space to describe special design considerations requested by the institution or constraints that limit the choice of design alternatives. Design constraints that affect system alternatives selection must be documented here as well as in the report documentation.

## Project Summary Information

### Project Summary

Project Name \_\_\_\_\_

Institution Name \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Building Type \_\_\_\_\_ Building Square Footage \_\_\_\_\_

Number of Floors \_\_\_\_\_ Estimated Number of Occupants \_\_\_\_\_

Slab-on-grade? \_\_\_\_\_ Partially below grade? \_\_\_\_\_

Mechanical cooling? \_\_\_\_\_ Renewable resources used? \_\_\_\_\_

On-site electric generation? \_\_\_\_\_ Estimated annual occupancy hours \_\_\_\_\_

### Institution Contact

Contact Person \_\_\_\_\_ Title \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Telephone \_\_\_\_\_ Fax \_\_\_\_\_

### Design Professional Contacts

Architectural Firm \_\_\_\_\_

Architect Name \_\_\_\_\_ Title \_\_\_\_\_

Support Staff Name \_\_\_\_\_ Title \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Telephone \_\_\_\_\_ Fax \_\_\_\_\_

Engineering Firm \_\_\_\_\_

Engineer Name \_\_\_\_\_ Title \_\_\_\_\_

Support Staff Name \_\_\_\_\_ Title \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Telephone \_\_\_\_\_ Fax \_\_\_\_\_

**Special Design Considerations** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



## Section 4: Assumptions Form

The *Assumptions Form* provides a central location for documenting assumptions made in the analysis (refer to the next page). Assumptions regarding initial energy rates used in the analysis are to be provided. The energy rates should be entered for both summer and winter, as applicable. In the case of on-site electricity generation, this should also include information about utility buyback rates.

The next area provides a location to document other assumptions made in the analysis. Examples of other assumptions include the quantity of domestic hot water used annually, and maintenance costs.

The final area on the *Assumptions Form* provides a location to document references used. These references include, but are not limited to, those used to perform calculations and those used to estimate construction costs. Additional pages may be added as necessary to list all of the assumptions and references.

<b>Assumptions Form</b>
-------------------------

Estimated Average Initial Fuel Costs:

	Summer	Winter
Natural Gas (\$/Therm)		
Electricity (\$/kWh)		
Electricity (\$/kW Demand)		
Liquefied Petroleum Gas (LPG) (\$/gal)		
Other (Specify)		
Assumptions Relating to Fuel Costs _____ _____ _____ _____ _____		

**Other Assumptions**

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_

**References**

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_

## Section 5: Discount Factor Summary

Factors used in the report are to be recorded in the *Discount Factor Summary* form (refer to the next page). As mentioned previously, these factors are from the annual supplement to Handbook 135 *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis* from U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) for Iowa. This document is updated and posted each April. A sample of data is shown on the first line of the table. The following link has discount factors that can be used until the annual supplement is updated in April 2008.

<http://www1.eere.energy.gov/femp/pdfs/ashb07.pdf>

<b>Discount Factor Summary</b>
--------------------------------

**Discount Factor Summary**

Year	Table References			
	A-1 nonfuel SPV factor	A-2 nonfuel UPV factor	Ba-2 fuel UPV factor (Commercial)	
			Electric	Natural Gas
25*	0.478	17.41	17.67	14.89

\* Sample data from ASHB07.pdf (3.0% Discount Rate (DOE))

## Section 6: Life-Cycle Cost Analysis

The life cycle cost calculations for each alternative are presented in this section of the report. The forms provided in the Appendix of these guidelines are the preferred reporting method. These forms come from Appendix C of the *Life-Cycle Costing Manual for the Federal Energy Management Program*, National Institute for Standards and Technology (NIST) Handbook 135, 1995 Edition. This manual can be ordered or downloaded on the internet as mentioned previously. Directions for the use of each form are presented on the adjoining pages in Appendix C.

At least fifteen alternative cases are to be studied (eighteen if the project includes on-site electricity generation). A set of forms are to be presented for each case.

The analysis of each system (domestic hot water, lighting, envelope/HVAC, and electricity generation) should begin with a base case that would be expected to provide the lowest installed cost that still meets the energy code but, due to lower efficiency, usually result in high operating and life cycle costs. The other options should provide a tradeoff of higher installed cost for lower operating and (potentially) lower life cycle costs. In each case, the system with the lowest life cycle cost must be recommended.

### **Domestic Hot Water**

Evaluate three domestic hot water systems and document the rationale to justify their consideration for the facility. Systems selection could compare varying efficiency levels, systems using different fuels, a central system versus a distributed system, a solar-assisted versus a non-assisted system, a variety of control strategies, or large central equipment versus a modular installation, for example.

### **Lighting**

Evaluate three lighting systems for the primary use of the building (classrooms for example) and document the rationale to justify their consideration for the facility. Include a variety of lamp types, ballast features, and control strategies.

The analysis may also require the study of secondary use lighting (such as for gymnasiums and for parking lots, for example).

### **Building Envelope and HVAC Systems**

Evaluate three building envelope types and three HVAC systems and document the rationale to justify their consideration for the facility. A total of nine building and HVAC combinations must be studied. The design alternatives recommended previously for the domestic hot water system and for the lighting system should be used in the analysis of the envelope and HVAC systems.

Building envelope parameters may vary wall and roof insulation type and thickness, and window type. HVAC system parameters may vary system type, central and modular equipment, distribution system type, control strategies, etc.

### **On-Site Electricity Generation**

When applicable, use all of the recommended building systems to evaluate three design alternatives for on-site electricity generation. Potential alternatives include engine generators, micro-turbines, fuel cells, steam turbines, wind turbines, solar arrays (photovoltaic systems), etc. In the case of wind turbine electricity generation, refer to the Department's current version of the *Wind Feasibility Study Guidelines*.

### **Recommended Systems**

Briefly note each of the recommended systems, however, most of this discussion should be provided in the Executive Summary. The set of combined systems should be used to find the detailed energy use prediction on the Life-Cycle Cost Analysis form in the Executive Summary.

## **Section 7: Appendix**

The report appendix is to include supporting information. The contents of the appendix should include sketches of the planned building layout, energy use calculations, and any other pertinent information necessary to document the justification for the recommendations that are made.

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## **GUIDELINE APPENDICES**

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## **Appendix A**

### ***Life Cycle Cost Analysis Forms***

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## LIFE-CYCLE COST ANALYSIS

### 1. PROJECT IDENTIFICATION

PROJECT TITLE \_\_\_\_\_FY\_\_\_\_\_

LOCATION \_\_\_\_\_DoE REGION\_\_\_\_\_

BASE DATE \_\_\_\_\_SERVICE DATE\_\_\_\_\_

DESIGN FEATURE \_\_\_\_\_

CONSTRAINTS \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

TYPE OF STUDY:    ☒ Energy and  
                              Water Conservation &  
                              Renewable Resources  
                              (FEMP)                                ☐ Other  
  (OMB A-94)

### BASE CASE AND ALTERNATIVES FOR LCC ANALYSIS

(A) \_\_\_\_\_  
\_\_\_\_\_

(B) \_\_\_\_\_  
\_\_\_\_\_

(C) \_\_\_\_\_  
\_\_\_\_\_

(D) \_\_\_\_\_  
\_\_\_\_\_

(E) \_\_\_\_\_  
\_\_\_\_\_

Analyst \_\_\_\_\_Phone \_\_\_\_\_Date of Study\_\_\_\_\_

## 1. Project Identification INSTRUCTIONS

### Step 1. PROJECT IDENTIFICATION

- Enter project name and fiscal year.
- Enter location. Enter DoE region (from *Annual Supplement*).
- Enter Base Date and Service Date.
- Enter design feature to be evaluated.
- List constraints. Add page if needed.
- Designate study as energy conservation study or OMB study.

### Step 2. BASE CASE AND ALTERNATIVES

- Give title and brief description of base case and alternatives to be analyzed.

### Step 3. GENERAL INFORMATION

- Enter name of analyst, telephone number, and date study was completed.

[illegible]

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### 3. Input Data Summary INSTRUCTIONS

#### Step 1. IDENTIFICATION OF ALTERNATIVE

- Enter project title and identification data for alternative from *Project Identification* worksheet.

#### Step 2. ANALYSIS INPUT DATA

Col. (1) Enter types of costs or benefits as of the Base Date (BD):

**One-time amounts:**

Examples: Planning/Construction (P/C) or Acquisition Costs  
Capital Replacement Costs  
Major Repair Costs  
Disposal Costs  
Resale, Retention, or Salvage Value

*Note: P/C or Acquisition Costs may be assumed to occur in a lump sum at the beginning of the study period. All other one-time costs are assumed to occur at any time during the analysis period, the specific time depending on when they are actually expected to occur.*

**Annually recurring amounts:**

Examples: Routine OM&R Costs and Custodial Costs  
Energy Costs: Electricity, distillate, residual, etc.  
Water Costs

Col. (2) Enter \$-amounts as of the Base Date. (Designate as thousands or millions.)

Col. (3) For **one-time amounts**, enter the number of years after the Base Date (BD) and Service Date (SD) for which the costs or benefits occur.  
For **annually recurring amounts**, enter the number of annual payments expected over the length of the study period.

Col. (4) Designate as investment-related or non-investment-related.

Col. (5) List data sources on a separate sheet and enter references here.

Col. (6) Enter differential escalation rates(s) for costs other than energy, if applicable.

Col. (7) Enter number of appropriate Discount Factor Table (for region, fuel type, sector, discount rate, differential escalation rate) from *Annual Supplement to Handbook 135*.



# LIFE-CYCLE COST ANALYSIS

## 4. PRESENT-VALUE CALCULATIONS

Project Title \_\_\_\_\_ Alt. ID \_\_\_\_\_

(1) INVESTMENT- RELATED AMOUNTS	(2) \$-Amount on BD \$ x 10 <sup>3</sup> <input type="text"/> \$ x 10 <sup>6</sup> <input type="text"/>	(3) Discount Factor	(4) Present Value (4) = (2)x(3)	(5) PV TOTALS (5) = Summation of (4) by type
				Initial Investment \$ <input type="text"/>
				Capital Replacements + \$ <input type="text"/>
				Disposal Costs + \$ <input type="text"/>
				Salvage/ Resale Value - \$ <input type="text"/>
				TOTAL INV.- RELATED COSTS <input type="text"/>
OPERATION-RELATED AMOUNTS	\$-Amount on BD \$ x 10 <sup>3</sup> <input type="text"/> \$ x 10 <sup>6</sup> <input type="text"/>	Discount Factor	Present Value (4) = (2)x(3)	
				Annual OM&R \$ <input type="text"/>
				Non-Annual OM&R + \$ <input type="text"/>
				Energy + \$ <input type="text"/>
				Water + \$ <input type="text"/>
				Other ± \$ <input type="text"/>
				TOTAL OPERATION- REL. COSTS <input type="text"/>
TOTAL PV LIFE-CYCLE COSTS			=	\$ <input type="text"/>

BD = Base Date

#### 4. Present-Value Calculations INSTRUCTIONS

##### Step 1. IDENTIFICATION OF ALTERNATIVES

- Enter project name and identification data for base case or alternative.

##### Step 2. PRESENT VALUE CALCULATION

- |          |  |
|----------|--|
| Col. (1) | Enter costs and benefits by category (investment-related or operation-related).                        |
| Col. (2) | Enter \$-amounts as of the Base Date, from column (2) of <i>Input Data Summary</i> .                   |
| Col. (3) | Enter discount factors from tables identified in column (7) of <i>Input Data Summary</i> .             |
| Col. (4) | Multiply \$-amount (column (2)) by discount factor (column (3)) and enter present value in column (4). |

##### Step 3. LIFE-CYCLE COST CALCULATION

- |          |  |
|----------|--|
| Col. (5) | <ul style="list-style-type: none"> <li>• Sum all investment-related costs (including resale, retention, or salvage values, if any, that have to be subtracted from costs). Enter in box.</li> <li>• Sum all operation-related costs and enter in box.</li> <li>• Add total investment-related costs and total operation-related costs from boxes and enter Total PV Life-Cycle Costs for alternative in bottom part of worksheet.</li> </ul> |
|----------|--|

## **Appendix B**

### ***Applicable Iowa Laws***

## Iowa Code 2007

**Notice and Disclaimer -- Unofficial Posting .** The files making up this *Internet Version* of the 2007 Iowa Code do not constitute the official text of the law. The text in these files may not always be formatted exactly like the text in the *Printed Version* . The *Printed Version* of the Code should be consulted for all legal matters requiring reliance on the text of the law.

<http://nxtsearch.legis.state.ia.us/NXT/gateway.dll/2007%20Iowa%20Code/2007code/1/27534?f=templates&fn=defaultURLquerylink.htm>

### CHAPTER 470

#### LIFE CYCLE COST ANALYSIS OF PUBLIC FACILITIES

##### 470.1 Definitions.

##### 470.2 Policy - analysis required.

##### 470.3 Elements of analysis.

##### 470.4 Analysis approved.

##### 470.5 Exceptions.

##### 470.6 Restriction on use of public funds.

##### 470.7 Life cycle cost analysis - approval.

##### 470.8 Life cycle cost analysis - implementation and exemptions.

#### 470.1 Definitions.

As used in this chapter unless the context otherwise requires:

1. "Commissioner" means the state building code commissioner.
  2. "Department" means the department of natural resources.
  3. "Director" means the director of the department of natural resources.
  4. "Economic life" means the projected or anticipated useful life of a facility as expressed by a term of years.
  5. "Energy system" includes but is not limited to the following equipment or measures:
    - a. Equipment used to heat or cool the facility.
    - b. Equipment used to heat water in the facility.
    - c. On-site equipment used to generate electricity for the major facility.
    - d. On-site equipment that uses the sun, wind, oil, natural gas, coal or electricity as a power source.
    - e. Energy conservation measures in the facility design and construction that decrease the energy requirements of the facility.
  6. "Facility" means a building having twenty thousand square feet or more of usable floor space that is heated or cooled by a mechanical or electrical system or any building, system, or physical operation which consumes more than forty thousand British thermal units (BTUs) per square foot per year.
  7. "Initial cost" means the moneys required for the capital construction or renovation of a facility.
  8. "Life cycle cost analysis" means an analytical technique that considers certain costs of owning, using and operating a facility over its economic life including but not limited to the following:
    - a. Initial costs.
    - b. System repair and replacement costs.
    - c. Maintenance costs.
    - d. Operating costs, including energy costs.
    - e. Salvage value.
  9. "Public agency" means a state agency, political subdivision of the state, school district, area education agency, or community college.
  10. "Renovation" means a project where additions or alterations exceed fifty percent of the value of a facility and will affect an energy system.
- [C81, §470.1]  
91 Acts, ch 253, §17, 18

#### 470.2 Policy - analysis required.

The general assembly declares that energy management is of primary importance in the design of publicly owned facilities. Commencing January 1, 1980, a public agency responsible for the construction or renovation of a facility shall, in a design begun after that date, include as a design criterion the requirement that a life cycle cost analysis be conducted for the facility. The objectives of the life cycle cost analysis are to optimize energy efficiency at an acceptable life cycle cost. The life cycle cost analysis shall meet the requirements of section 470.3 .

[C81, §470.2]

#### 470.3 Elements of analysis.

1. A life cycle cost analysis shall include but is not limited to the following elements:

- a. Specification of energy management objectives and health, safety and functional constraints. The facility design shall comply with applicable state or local building code requirements.
- b. Identification of the energy needs of the facility and energy system alternatives to meet those needs.
- c. Cost of the energy system alternatives identified in paragraph "b" of this subsection.
- d. Determination of amounts and timing of cash flow.
- e. Calculation of life cycle cost using an economic model such as, but not limited to, rate of return, annual equivalent cost or present equivalent cost.
- f. Evaluation of design and system alternatives using a method such as, but not limited to, design matrixes, ranking tables or network analysis.

2. A public agency or a person preparing a life cycle cost analysis for a public agency shall consider the methods and analytical models provided by the department and available through the commissioner, which are suited to the purpose for which the project is intended. Within sixty days of final selection of a design architect or engineer, a public agency, which is also a state agency under section 7D.34 , shall notify the commissioner and the department of the methodology to be used to perform the life cycle cost analysis, on forms provided by the department.

[C81, §470.3]

88 Acts, ch 1179, §6; 91 Acts, ch 253, §19

#### **470.4 Analysis approved.**

The life cycle cost analysis shall be approved by the public agency before contracts for the construction or renovation are let. A public agency may accept a facility design and shall meet the requirements of this chapter if the design meets the operational requirements of the agency and provides the optimum life cycle cost. The public agency shall retain a copy of the life cycle cost analysis and a statement justifying a design decision both of which shall be available for public inspection at reasonable hours.

[C81, §470.4]

#### **470.5 Exceptions.**

This chapter does not apply to buildings used on January 1, 1980 by the division of adult corrections of the department of human services as maximum security detention facilities or to the renovation of property nominated to, or entered in the national register of historic places, designated by statute, or included in an established list of historic places compiled by the historical division of the department of cultural affairs.

[C81, §470.5; 82 Acts, ch 1238, §22]

83 Acts, ch 96, §157, 159

#### **470.6 Restriction on use of public funds.**

Public funds shall not be used for the construction or renovation of a facility unless the design for the work is prepared in accordance with this chapter and the actual construction or renovation meets the requirements of the design.

[C81, §470.6]

#### **470.7 Life cycle cost analysis - approval.**

The public agency responsible for the new construction or renovation of a public facility shall submit a copy of the life cycle cost analysis for review by the commissioner who shall consult with the department. If the public agency is also a state agency under section 7D.34 , comments by the department or the commissioner, including any recommendation for changes in the analysis, shall, within thirty days of receipt of the analysis, be forwarded in writing to the public agency. If either the department or the commissioner disagrees with any aspects of the life cycle cost analysis, the public agency affected shall timely respond in writing to the commissioner and the department. The response shall indicate whether the agency intends to implement the recommendations and, if the agency does not intend to implement them, the public agency shall present its reasons. The reasons may include, but are not limited to, a description of the purpose of the facility or renovation, preservation of historical architectural features, architectural and site considerations, and health and safety concerns.

Within thirty days of receipt of the response of the public agency affected, the department, the commissioner, or both, shall notify in writing the public agency affected of the department's, the commissioner's, or both's agreement or disagreement with the response. In the event of a disagreement, the department, the commissioner, or both, shall at the same time transmit the notification of disagreement with response and related papers to the executive council for resolution pursuant to section 7D.34 . The life cycle cost analysis process, including submittal and approval, and implementation exemption requests pursuant to section 470.8 , shall be completed prior to the letting of contracts for the construction or renovation of a facility.

88 Acts, ch 1179, §7; 89 Acts, ch 315, §28; 91 Acts, ch 253, §20

#### **470.8 Life cycle cost analysis - implementation and exemptions.**

The public agency responsible for the new construction or renovation of a public facility shall implement the recommendations of the life cycle cost analysis.

The commissioner, in consultation with the director, shall, by rule, develop criteria to exempt facilities from the implementation requirements of this section. Using the criteria, the commissioner, in cooperation with the director, shall exempt facilities on a case by case basis. Factors to be considered when developing the exemption criteria shall include, but not be limited to, a description of the purpose of the facility or renovation, the preservation of historical architectural features, site considerations, and health and safety concerns. The commissioner and the director shall grant or deny a request for exemption from the requirements of this section within thirty days of receipt of the request.

91 Acts, ch 253, §21

## CHAPTER 473

### ENERGY DEVELOPMENT AND CONSERVATION

This chapter not enacted as a part of this title;  
transferred from chapter 93 in Code 1993

473.1 Definitions.

473.2 Findings.

473.3 Energy efficiency goal.

473.4 through 473.6 Reserved.

473.7 Duties of the department.

473.8 Emergency powers.

473.9 Set-aside definitions.

473.10 Reserve required.

473.11 Energy conservation trust established - receipts and disbursements.

473.12 Implementation of energy conservation measures - state board of regents. Repealed by 2005 Acts, ch 179, §160.

473.13 Implementation of energy conservation measures - state department of transportation.

473.13A Energy conservation measures identified and implemented.

473.14 Reserved.

473.15 Annual report.

473.16 Additional funds.

473.17 Review.

473.18 Reserved.

473.19 Energy bank program.

473.20 Energy loan fund.

473.20A Self-liquidating financing.

473.21 through 473.39 Reserved.

473.40 Statewide building energy efficiency rating system. Repealed by 2006 Acts, ch 1014, §10.

473.41 Reserved.

473.42 Exit signs - standards.

473.43 Reserved.

473.44 Plumbing products efficiency standards - penalty.

#### 473.1 Definitions.

As used in this chapter, unless the context otherwise requires:

1. "Commission" means the environmental protection commission of the department.
2. "Department" means the department of natural resources created under section 455A.2 .
3. "Director" means the director of the department or a designee.
4. "Energy" or "energy sources" means gasoline, fuel oil, natural gas, propane, coal, special fuels and electricity.
5. "Supplier" means any person engaged in the business of selling, importing, storing or generating energy sources in Iowa.  
[C75, 77, 79, 81, §93.1]  
86 Acts, ch 1245, §1817 - 1819  
C93, §473.1

473.2 to 473.18 not provided in these guidelines

#### 473.19 Energy bank program.

The energy bank program is established by the department. The energy bank program consists of the following forms of assistance for the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, and nonprofit organizations:

1. Providing moneys from the petroleum overcharge fund for conducting energy audits for school districts under section 279.44 , for conducting comprehensive engineering analyses for school districts and for conducting energy audits and comprehensive engineering analyses for state agencies, and political subdivisions of the state.
2. Providing loans, leases, and other methods of alternative financing from the energy loan fund established in section 473.20 and section 473.20A for the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, and nonprofit organizations to implement energy conservation measures.
3. Serving as a source of technical support for energy conservation management.
4. Providing assistance for obtaining insurance on the energy savings expected to be realized from the implementation of energy conservation measures.
5. Providing self-liquidating financing for the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, and nonprofit organizations pursuant to section 473.20A .

For the purpose of this section, section 473.20 , and section 473.20A , "energy conservation measure" means construction, rehabilitation, acquisition, or modification of an installation in a facility or vehicle which is intended to reduce energy consumption, or energy costs, or both, or allow the use of an alternative energy source, which may contain integral control and measurement

devices. "Nonprofit organization" means an organization exempt from federal income taxation under section 501(c)(3) of the Internal Revenue Code.

86 Acts, ch 1167, §2

C87, §93.19

87 Acts, ch 209, §1; 90 Acts, ch 1253, §120, 121; 91 Acts, ch 253, §7

C93, §473.19

#### **473.20 Energy loan fund.**

An energy loan fund is established in the office of the treasurer of state to be administered by the department.

1. The department may make loans to the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, and nonprofit organizations for implementation of energy conservation measures identified in a comprehensive engineering analysis. Loans shall be made for all cost-effective energy management improvements. For the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, and nonprofit organizations to receive a loan from the fund, the department shall require completion of an energy management plan including an energy audit and a comprehensive engineering analysis. The department shall approve loans made under this section.

2. Cities and counties shall repay the loans from moneys in their debt service funds. Area education agencies shall repay the loans from any moneys available to them.

School districts and community colleges may enter into financing arrangements with the department or its duly authorized agents or representatives obligating the school district or community college to make payments on the loans beyond the current budget year of the school district or community college. Chapter 75 shall not be applicable. School districts shall repay the loans from moneys in either their general fund or debt service fund. Community colleges shall repay the loans from their general fund. Other entities receiving loans under this section shall repay the loans from any moneys available to them.

3. The department may accept gifts, federal funds, state appropriations, and other moneys for deposit in the energy loan fund or may fund the energy loan fund in accordance with section 473.20A .

4. For the purpose of this section, "loans" means loans, leases, or alternative financing arrangements.

5. The state, state agencies, political subdivisions of the state, school districts, area education agencies, and community colleges shall design and construct the most energy cost-effective facilities feasible and shall use the financing made available by the department to cover the incremental costs above minimum building code energy efficiency standards of purchasing energy efficient devices and materials unless other lower cost financing is available. As used in this section, "facility" means a structure that is heated or cooled by a mechanical or electrical system, or any system of physical operation that consumes energy to carry out a process.

6. The department shall not require the state, state agencies, political subdivisions of the state, school districts, area education agencies, and community colleges to implement a specific energy conservation measure identified in a comprehensive engineering analysis if the entity which prepared the analysis demonstrates to the department that the facility which is the subject of the energy conservation measure is unlikely to be used or operated for the full period of the expected payback of the energy conservation measure.

86 Acts, ch 1167, §3

C87, §93.20

87 Acts, ch 209, §2; 90 Acts, ch 1252, §12; 90 Acts, ch 1253, §120; 91 Acts, ch 253, §8

C93, §473.20

94 Acts, ch 1029, §30; 2001 Acts, ch 60, §1

#### **473.20A Self-liquidating financing.**

1. The department of natural resources may enter into financing agreements with the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, or nonprofit organizations in order to provide the financing to pay the costs of furnishing energy conservation measures. The provisions of section 473.20 defining eligible energy conservation measures and the method of repayment of the loans apply to financings under this section.

The financing agreement may contain provisions, including interest, term, and obligations to make payments on the financing agreement beyond the current budget year, as may be agreed upon between the department of natural resources and the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, or nonprofit organizations.

2. For the purpose of funding its obligation to furnish moneys under the financing agreements, or to fund the energy loan fund created in section 473.20 , the treasurer of state, with the assistance of the department of natural resources, or the treasurer of state's duly authorized agents or representatives, may incur indebtedness or enter into master lease agreements or other financing arrangements to borrow to accomplish energy conservation measures, or the department of natural resources may enter into master lease agreements or other financing arrangements to permit the state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, or nonprofit organizations to borrow sufficient funds to accomplish the energy conservation measure. The obligations may be in such form, for such term, bearing such interest and containing such provisions as the department of natural resources, with the assistance of the treasurer of state, deems necessary or appropriate. Funds remaining after the payment of all obligations have been redeemed shall be paid into the energy loan fund.

3. The state, state agencies, political subdivisions of the state, school districts, area education agencies, community colleges, and nonprofit organizations may enter into financing agreements and issue obligations necessary to carry out the provisions of the chapter. Chapter 75 shall not be applicable.

87 Acts, ch 209, §3

CS87, §93.20A

90 Acts, ch 1253, §120; 91 Acts, ch 253, §9

C93, §473.20A

473.21 to 473.44 not provided in these guidelines

## CHAPTER 7D EXECUTIVE COUNCIL

- 7D.1 Membership.
- 7D.2 Secretary.
- 7D.3 Records kept.
- 7D.4 and 7D.5 Reserved.
- 7D.6 Report - official register.
- 7D.7 Reserved.
- 7D.8 Anticipation of revenues.
- 7D.9 Compromise of claims.
- 7D.10 Court costs.
- 7D.10A Allocation to manure storage indemnity fund.
- 7D.11 Report of unexpended balances.
- 7D.12 Notice to transfer balance.
- 7D.13 Order of transfer.
- 7D.14 Duty to transfer.
- 7D.15 Public policy research foundation.
- 7D.16 through 7D.28 Reserved.
- 7D.29 Performance of duty - expense.
- 7D.30 Necessary record.
- 7D.31 Additional compensation and expenses.
- 7D.32 Reserved.
- 7D.33 State employee suggestion system. Repealed by 2003 Acts, ch 145, §291.
- 7D.34 Energy conservation lease-purchase.
- 7D.35 Dispute resolution.

### **7D.34 Energy conservation lease-purchase.**

1. As used in this section:

*a. "Energy conservation measure"* means installation or modification of an installation in a building which is primarily intended to reduce energy consumption or allow the use of an alternative energy source, which may contain integral control and measurement devices.

*b. "State agency"* means a board, department, commission or authority of or acting on behalf of the state having the power to enter into contracts with or without the approval of the executive council to acquire property in its own name or in the name of the state. "State agency" does not mean the general assembly, the courts, the governor or a political subdivision of the state.

2. *a.* A state agency may, with the approval of the executive council, lease as lessee real and personal properties and facilities for use as or in connection with any energy conservation measure for which it may so acquire real and personal properties and facilities, upon the terms, conditions and considerations the official or officials having the authority with or without the approval of the executive council to commit the state agency to acquire real and personal property and facilities deem in the best interests of the state agency. A lease may include provisions for ultimate ownership by the state or by the state agency and may obligate the state agency to pay costs of maintenance, operation, insurance and taxes. The state agency shall pay the rentals and the additional costs from the annual appropriations for the state agency by the general assembly or from other funds legally available. The lessor of the properties or facilities may retain a security interest in them until title passes to the state or state agency. The security interest may be assigned or pledged by the lessor. In connection with the lease, the state agency may contract for a letter of credit, insurance or other security enhancement obligation with respect to its rental and other obligations and pay the cost from annual appropriations for such state agency by the general assembly or from other funds legally available. The security enhancement arrangement may contain customary terms and provisions, including reimbursement and acceleration if appropriate. This section is a complete and independent authorization and procedure for a state agency, with the approval of the executive council, to enter into a lease and related security enhancement arrangements and this section is not a qualification of any other powers which a state agency may possess, including those under chapter 262, and the authorization and powers granted under this section are not subject to the terms or requirements of any other provision of the Code.

*b.* Before a state agency seeks approval of the executive council for leasing real or personal properties or facilities for use as or in connection with any energy conservation measure, the state agency shall have a comprehensive engineering analysis done on a building in which it seeks to improve the energy efficiency by an engineering firm approved by the department of natural resources through a competitive selection process and the engineering firm is subject to approval of the executive council. Provisions of this section shall only apply to energy conservation measures identified in the comprehensive engineering analysis.

*c.* Before the executive council gives its approval for a state agency to lease real and personal properties or facilities for use as or in connection with any energy conservation measure, the executive council shall in conjunction with the department of natural resources and after review of the engineering analysis submitted by the state agency make a determination that the properties or



facilities will result in energy cost savings to the state in an amount that results in the state recovering the cost of the properties or facilities within six years after the initial acquisition of the properties or facilities.

85 Acts, ch 55, §1

CS85, §19.34

C93, §7D.34

#### **7D.35 Dispute resolution.**

The executive council shall resolve any disputes transmitted to it by the department of natural resources, the state building code commissioner, or both, arising under section [470.7](#).

89 Acts, ch 315, §26

CS89, §19.35

C93, §7D.35

## **CHAPTER 72**

### **DUTIES RELATING TO PUBLIC CONTRACTS**

[72.1 Contracts for excess expenditures - exception for coal.](#)

[72.2 Executive council may authorize indebtedness.](#)

[72.3 Divulging contents of sealed bids.](#)

[72.4 Penalty.](#)

[72.5 Life cycle cost.](#)

#### **72.5 Life cycle cost.**

1. A contract for a public improvement or construction of a public building, including new construction or renovation of an existing public building, by the state, or an agency of the state, shall not be let without satisfying the following requirements:

*a.* A design professional submitting a design development proposal for consideration of the public body shall at minimum prepare one proposal meeting the design program's space and use requirements which reflects the lowest life cycle cost possible in light of existing commercially available technology.

*b.* Submission of a cost benefit analysis of any deviations from the lowest life cycle cost proposal contained in other design proposals requested by or prepared for submission to the public body.

The public body may request additional design proposals in light of funds available for construction, aesthetic considerations, or any other reason.

This subsection applies for all design development proposals requested on or after January 1, 1991.

2. The director of the department of natural resources in consultation with the department of management, state building code commissioner, and state fire marshal, shall develop standards and methods to evaluate design development documents and construction documents based upon life cycle cost factors, to facilitate fair and uniform comparisons between design proposals and informed decision making by public bodies.

3. The department of management shall develop a proposal for submission to the general assembly on or before January 10, 1991, to create a division within the department of management to evaluate life cycle costs on design proposals submitted on public improvement and construction contracts for agencies of the state, to assure uniform comparisons and professional evaluations of design proposals by an independent agency. The report shall also address potential redundancy and conflicts within existing state law regarding life cycle cost analysis and recommend the resolution of any problems which are identified.

4. It is the intent of the general assembly to discourage construction of public buildings based upon lowest acquisition cost, and instead to require that such decisions be based upon life cycle costs to reduce energy consumption, maintenance requirements, and continuing burdens upon taxpayers.

90 Acts, ch 1252, §5; 94 Acts, ch 1173, §5; 2004 Acts, ch [1086](#), [§17](#); 2006 Acts, ch [1014](#), [§1](#)

Subsection 2 amended

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## **Appendix C**

### ***Equipment Service Lives***

## Recommended Economic Lifetimes of Various Mechanical Systems

EQUIPMENT ITEM	ECONOMIC LIFE (yrs)
absorption liquid chilling system .....	20
air compressors .....	20
air conditioner single package, air-cooled, hermetic .....	10
air conditioner with remote air-cooled condenser .....	10
air-cooled single package air conditioner, hermetic .....	10
air-cooled split system air conditioners .....	10
air handling units horizontal and vertical .....	20-25
air side equipment .....	20
boilers .....	20-25
burners .....	10
central station units .....	20
centrifugal chillers .....	20-30
centrifugal compressors, multistage .....	30
centrifugal compressors, single stage .....	20
centrifugal liquid chilling systems .....	20-30
chillers, absorption .....	20
chillers, reciprocating, up to 150 TR .....	12
chillers, reciprocating, 150 TR and up .....	14
coils, heating and cooling .....	indefinite
comm. air conditioners, remote a.c. condenser .....	10
comm. water-cooled conditioners, single package .....	10
compressors, reciprocating v/w, hermetic .....	12
compressors, reciprocating v/w, open .....	14
compressor units, vertical single-acting .....	30
condensers, evaporative, ammonia .....	20
condensers, evaporative .....	20
condensers, horizontal shell and tube, ammonia .....	20
condensers, horizontal shell and tube .....	20
condensers, remote air-cooled .....	12
condensing units, reciprocating v/w, hermetic .....	12
condensing units, reciprocating v/w, open .....	14
condensing units, vertical single-acting .....	30
controls, electric and pneumatic .....	20
cooling coils .....	indefinite
cooling towers, masonry fill .....	45
cooling towers, metal fill .....	15-20
cooling towers, wood fill .....	15-20
diesel engines .....	10-12
electric furnaces .....	10

**continued**

EQUIPMENT ITEM	ECONOMIC LIFE (yrs)
electric heating, add on .....	10
electric motors .....	20-25
evaporative condensers .....	20
evaporators, ammonia.....	30
evaporators, pinned coil, ammonia .....	20
evaporators, spiral pinned, ammonia .....	20
fans, backward curved (airfoil).....	20
fans, coil multiple space conditions .....	20
fans, coil multiple space conditions .....	20
fan coil room conditions.....	20
fans, forward curved .....	20
fans, utility sets.....	20
float regulators, high pressure, ammonia .....	30
float regulators, low pressure, ammonia.....	30
furnaces, gas fired .....	10
furnaces, oil fired .....	10
gas fired furnaces.....	10
gasoline engines .....	10
heat pumps, single package, air-to-air .....	20*
heat pumps, single package, water-to-air.....	20*
heat pumps, split system, air-to-air.....	20*
hermetic year-round air conditioners .....	14
high pressure receivers .....	30
high pressure receivers, ammonia .....	30
horizontal shell and tube liquid chillers, ammonia .....	30
horizontal shell and tube condensers.....	30
horizontal shell and tube condensers, ammonia .....	30
induction room air units .....	indefinite
liquid chilling systems, centrifugal .....	20
liquid coolers, horizontal shell and tube.....	30
low temperature compressor units, recip. v/w, hermetic.....	12
low temperature compressor units, recip, v/w, open .....	14
multistage centrifugal compressors .....	30
multistage turbo compressors .....	20
multizone central station units .....	20
multizone rooftop units .....	10
multiple space fan coil units .....	20
oil fired furnaces .....	10
oil receivers .....	NA
packaged refrigeration units .....	12

**continued**

EQUIPMENT ITEM	ECONOMIC LIFE (yrs)
packaged terminal units .....	10
plug type, refrigeration units .....	12
produce storage units .....	12
product coolers .....	20
product coolers, ammonia .....	20
pumps, centrifugal .....	20-25
residential water-cooled conditioners, single package .....	10
remote air-cooled condenser .....	12
room air conditioners .....	8
room units .....	8
turbines (steam) .....	10-30

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